COAL-CHEMICAL MATERIALS PRODUCED AT COKE PLANTS IN THE UNITED STATES 1948-57

BY JOSEPH A. DECARLO AND MAXINE M. OTERO

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CONTENTS

	Page		Page
Summary	1	Coke-oven tar	12
Introduction	2	Coke-oven crude light oil and derivatives	15
Acknowledgments	2	Coke-oven ammonia	19
Coke-oven gas	8		

ILLUSTRATIONS

Fig.

1. Value of coal, coke, breeze, and coal-chemical materials per ton of coal carbonized, 1948–57 ---- 4
2. Receipts per unit for principal refined light oils and other products at oven-coke plants, 1948–57 ---- 5
3. Yield of principal coal-chemical materials per net ton of coal carbonized, 1948–57 ---- 6
4. Percentage of total value of coke-oven products from slot-type ovens supplied by coke and breeze, surplus gas, and chemical materials, 1948–57 ---- 7

TABLES

1. Relationship of value of coal-chemical materials used or sold to value of all products used, or sold by coke-plant operators ---- 3
2. Value of coal, coke, breeze, and coal-chemical materials per ton of coal carbonized ---- 3
3. Value of coal recovered by coal-chemical materials, in percent ---- 3
4. Average receipts from coal-chemical materials, per unit, sold by coke plants, in cents ---- 3
5. Average yield of coke, breeze, and coal-chemical materials per ton of coal carbonized ---- 3
6. Production and disposal of coke-oven gas, in million cubic feet ---- 8
7. Average yield of coke-oven gas per ton of coal carbonized, by States, in thousand cubic feet ---- 9
8. Production and disposal of coke-oven gas, by merchant and furnace plants, in million cubic feet ---- 9
9. Disposal of surplus coke-oven gas, by merchant and furnace plants, in million cubic feet ---- 9
10. Disposal of surplus coke-oven gas, in percent ---- 10
11. Disposal pattern of coke-oven gas per ton of coal carbonized, in thousand cubic feet ---- 10
12. Manufactured gas produced and purchased by gas utilities, by kinds of gas, in million therms ---- 10
13. Relationship of value of surplus gas used or sold by coke-plant operators to value of all coal-chemical materials sold ---- 10
14. Gas used to heat coke ovens, by kinds, in million cubic feet ---- 11
15. Production of crude coal tar from all sources, in gallons ---- 13
16. Coke-oven tar produced, used by producers, and sold, in thousand gallons ---- 13
17. Average yield of coke-oven tar per ton of coal carbonized, by States, in gallons ---- 13
18. Coke-oven tar refined by producers and creosote oil, crude chemical oil, and pitch-of-tar recovered ---- 14
19. Crude naphthalene produced and sold by coke-plant operators, in pounds ---- 14
20. Coke-oven crude light-oil produced, refined, and derived products obtained, in gallons ---- 16
21. Average yield of coke-oven crude light oil per ton of coal carbonized, by States, in gallons ---- 16
22. Light-oil derivatives produced at oven-coke plants, in gallons ---- 16
23. Yield of light-oil products from refining crude light oil at oven-coke plants, in percent ---- 17
24. Benzene and toluene produced at oven-coke plants, by grades, in gallons ---- 17
25. Production of benzene (excluding Motor grade), in thousand gallons ---- 17
26. Estimated supply of specification grades of benzene (excluding Motor grade), in thousand gallons ---- 18
27. Estimated consumption of commercial benzene (excluding Motor grade), by uses, in thousand gallons ---- 18
28. Production of coke-oven ammonia, in net tons ---- 19
29. Average yield of coke-oven ammonium sulfate or equivalent per ton of coal carbonized, by States, in pounds ---- 19
30. Coke-oven ammonia produced by merchant and furnace plants, in net tons ---- 20
31. Production of chemical nitrogen, by sources, in net tons ---- 20
32. Wholesale prices per unit (20 pounds) of nitrogen at producing plants or ports, in bulk carlots, by kinds of material ---- 20

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COAL-CHEMICAL MATERIALS PRODUCED AT COKE PLANTS IN THE UNITED STATES 1948-57[1]

BY

JOSEPH A. DECARLO[2] AND MAXINE M. OTERO[3]

Summary

THE TOTAL VALUE of sales of coal-chemical materials in the 10-year period 1948–57 increased 34 percent or at an average annual rate of approximately 3.5 percent. According to the Chemical Industry Facts Book, third edition, 1957, published by Manufacturing Chemists' Association, Inc., the production of industrial chemicals since 1939 "has grown at an average rate of about 10 percent" a year (p. 7). The rapid growth of the chemical industry increased requirements of chemical raw materials at a faster pace than could be supplied by coal carbonization, and new sources of supply became necessary. The petroleum industry in the past decade increased tremendously the flow of chemical raw materials to the chemical industry through the processing of crude petroleum and natural gas. Whereas coal carbonization supplied most of the raw materials for manufacturing synthetic organic chemicals before World War II, coke ovens supplied only about 40 percent of the total used in 1957. Although the proportion of chemical raw materials supplied to the chemical industry by coke-oven operators declined, this source of supply is large and important to our economy.

In 1957, the value of coal-chemical materials sold, including surplus gas used by producing companies, totaled $358 million, compared with $267 million in 1948. Major factors that contributed to this gain were (1) increased production of all coal chemicals and (2) higher prices for tar and light-oil products. Gains in output of coal chemicals resulted principally from expansion in carbonizing capacity of coke plants owned and operated by the iron and steel industry, as yields of the basic coal-chemical materials (tar, ammonia, light oil, and gas) varied only slightly during the 10 years under review.

Coke-producing companies increased their revenues from converting coal to coke; by selling the coal-chemical materials that may have many and varied uses. Tables 1 to 3 show the economic importance of coal-chemical materials to coke-producing companies. Figures 1 to 4 illustrate trends in values, prices, and yields of coal-chemical materials during 1948–57. Surplus gas continued to rank second to coke in terms of value, but its margin in recent years has been steadily narrowed by gains made by tar and light-oil products groups. Light oil and its derivatives made the greatest gain percentagewise, with an advance of 73 percent in the 10 years. In terms of dollar value, however, tar and its derivatives made the greatest gain, with an increase of $0.364 per ton of coal carbonized.

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Although the values credited to light oil and tar products increased, revenue from ammonia products dropped substantially. The value credited to ammonia and its compounds fluctuated from $0.330 per ton of coal in 1950 to $0.422 in 1954, but after that year declined steadily because of reductions in ammonium sulfate prices; the reduced value was only $0.288 in 1957. Because the price of ammonium sulfate was very low in 1957, four coke plants discontinued its production. The high cost of sulfuric acid and the low market price made it impractical for these plants to continue recovering this material from their coke-oven gas (table 4).

The Bureau of Mines does not collect data on the total manufacturing costs of coke and coal chemicals; however, the value of coal—the raw material—is a substantial part of such costs, and relating product values to coal values does provide some measure as to changes in ratios of recovery values to costs. The percentages of coal costs recovered by various coal-chemical materials are shown in table 3. These data show the relative importance of each product group and reveal that the value credited to surplus gas, used and sold, amounted to approximately 16 percent of the coal costs. As gas represents such a large part of coal costs, coke-plant operators must have an assured outlet for this product under favorable economic conditions. The steel companies (furnace plants) have such an outlet, because most coke plants are integrated with iron- and steel-melting and annealing furnaces that can use the gas advantageously. Merchant plants, however, do not have this advantage, and loss of revenue from gas makes continued operations difficult. For this reason 13 merchant plants have closed since the end of World War II. Three of these were purchased by steel companies and were operated to produce metallurgical coke. Approximately 13 percent of coal costs is recovered through the sales of tar, and its derivatives and light-oil products return about 8 percent. The decline of ammonia and its compounds as a revenue producer to coke-plant operators is clearly shown in this table. In 1957 less than 3 percent of the coal costs was recovered from the sale of ammonia products.

In spite of increased emphasis on production and sales of coal-chemical materials in the past 10 years, the value of coal-chemical materials used or sold declined from 25 percent of all products in 1948, to 23 percent in 1957 (fig. 4). Coke and breeze, which account for roughly 75 percent by weight of the coal, were credited with about 77 percent of the value of all products in 1957. Average yield of coal-chemical materials per ton of coal carbonized is shown in table 5.

INTRODUCTION

This publication presents an economic review and statistical summary of coal-chemical materials recovered from coke-oven operations in the United States for 1948–57. Similar information for 1919–47 was published in Bureau of Mines Information Circular 7504, issued in 1949. The coal-chemical materials in this report include only those obtained by the high-temperature carbonization of coal in slot-type coke ovens and do not include any products recovered from low-temperature carbonization processes, or coal-gas retorts. Only products made by the coke-oven operators at the coke plants are included. Excluded are the secondary or finished products obtained from raw materials originating at coke plants but made by chemical manufacturers independently of the coke-oven operations, such as synthetic phenol, phthalic anhydride, styrene, etc. No attempt is made to review the many scientific and technical improvements made in coal carbonization during the period under study.

ACKNOWLEDGMENTS

The information used in this publication was obtained from annual reports voluntarily furnished by all coke-producing companies in the United States. The Bureau of Mines deeply appreciates their cooperation.

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TABLE 1.—*Relationship of value of coal-chemical materials used or sold to value of all products used or sold by coke-plant operators*

Year	Value of coal-chemical materials used or sold	Value of all products used or sold [1]	Percent of coal-chemical materials
1948	$292,019,139	$1,160,756,083	25.2
1949	258,168,195	1,073,895,266	24.0
1950	293,326,325	1,211,537,529	24.2
1951	348,784,126	1,385,681,992	25.2
1952	313,892,110	1,257,692,976	25.0
1953	375,645,869	1,478,534,558	25.4
1954	323,731,115	1,284,464,604	25.2
1955	388,437,984	1,612,918,119	24.1
1956	383,354,279	1,683,775,455	22.8
1957	404,674,433	1,786,403,683	22.7

[1] These data are revised from those carried in Bureau of Mines Minerals Yearbook through 1957.

TABLE 2.—*Value of coal, coke, breeze, and coal-chemical materials per ton of coal carbonized*

Year	Coal	Ammonia and its compounds	Light oil and its derivatives	Surplus gas used or sold	Tar and its derivatives used or sold (including naphthalene)
1948	$8.13	$0.382	$0.434	$1.291	$0.875
1949	8.52	.390	.440	1.410	.736
1950	8.67	.330	.567	1.393	.772
1951	8.94	.352	.763	1.353	.907
1952	9.23	.391	.755	1.353	.927
1953	9.24	.375	.835	1.408	.935
1954	9.00	.422	.825	1.519	1.050
1955	8.84	.352	.754	1.489	1.099
1956	9.35	.315	.773	1.481	1.172
1957	9.91	.288	.749	1.570	1.239

TABLE 2.—*Value of coal, coke, breeze, and coal-chemical materials per ton of coal carbonized*—Continued

Year	Other products	Total coal-chemical materials	Breeze produced	Coke produced	Coke, breeze, and coal-chemical materials
1948	$0.021	$3.003	$0.206	$8.728	$11.937
1949	.024	3.000	.197	9.282	12.479
1950	.028	3.090	.195	9.478	12.763
1951	.036	3.411	.194	9.945	13.550
1952	.027	3.458	.204	10.178	13.835
1953	.027	3.580	.216	10.296	14.092
1954	.009	3.825	.236	11.115	15.176
1955	.010	3.704	.237	11.439	15.380
1956	.008	3.749	.256	12.462	16.467
1957	.010	3.856	.283	12.885	17.024

TABLE 3.—*Value of coal recovered by coal-chemical materials, in percent*

Year	Ammonia and its compounds	Light oil and its derivatives	Surplus gas used or sold	Tar and its derivatives used or sold (including naphthalene)	Other products	Total	Value of coal per net ton
1948	4.7	5.3	15.9	10.8	0.2	36.9	$8.13
1949	4.6	5.2	16.5	8.6	.3	35.2	8.52
1950	3.8	6.6	16.1	8.9	.3	35.7	8.67
1951	4.0	8.6	15.1	10.1	.4	38.2	8.94
1952	4.2	8.2	14.7	10.0	.3	37.4	9.23
1953	4.1	9.1	15.2	10.1	.3	38.8	9.24
1954	4.7	9.2	16.9	11.6	.1	42.5	9.00
1955	4.0	8.6	16.8	12.4	.1	41.9	8.84
1956	3.4	8.3	15.8	12.5	.1	40.1	9.35
1957	2.9	7.6	15.8	12.5	.1	38.9	9.91

TABLE 4.—*Average receipts from coal-chemical materials, per unit, sold by coke plants, in cents*

Year	Tar, crude	Ammonia		Surplus gas used or sold	Benzene, all grades [1]	Toluene, all grades	Xylene, all grades	Solvent naphtha, crude and refined	Naphthalene, crude
		Sulfate	Liquor (NH_3 content)						
	Gallons	*Pounds*	*Pounds*	*M cubic feet*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Pounds*
1948	10.4	2.1	3.5	20.7	19.3	24.0	25.0	17.6	4.4
1949	8.5	2.3	3.9	22.2	19.8	21.1	25.3	18.3	4.4
1950	8.6	1.8	3.6	21.9	25.5	24.1	26.2	19.6	4.3
1951	9.9	1.9	4.0	21.2	33.7	30.5	31.8	23.0	5.3
1952	10.0	2.1	4.0	21.3	33.9	30.3	31.9	23.5	5.1
1953	10.3	2.2	4.2	22.0	38.6	31.2	32.0	25.1	4.8
1954	10.8	2.1	5.4	23.0	38.6	31.6	32.8	26.3	4.5
1955	11.5	1.9	4.2	22.7	34.8	29.9	32.1	25.7	5.5
1956	12.0	1.6	3.7	22.8	34.3	28.6	31.7	25.2	6.1
1957	13.0	1.3	3.3	24.0	34.4	27.6	30.9	26.0	[2]

[1] Excludes Motor grade.
[2] Data withheld to avoid disclosing individual company figures.

TABLE 5.—*Average yield of coke, breeze, and coal-chemical materials per ton of coal carbonized*

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Coke—pounds	1,404	1,400	1,409	1,408	1,405	1,403	1,396	1,403	1,408	1,408
Breeze—do	119	115	109	100	102	100	93	93	93	93
Tar—gallons	7.60	7.81	7.79	7.78	7.74	7.90	8.46	8.13	8.15	8.32
Ammonia—pounds	4.91	5.06	5.01	5.02	5.04	5.12	5.39	5.14	4.92	4.98
Ammonium sulfate or equivalent—do	19.52	20.08	19.89	19.82	19.92	20.09	21.09	20.06	19.28	19.56
Crude light oil—gallons	2.73	2.77	2.81	2.82	2.79	2.90	2.98	2.91	2.92	2.94
Gas—M cubic feet	10.23	10.25	10.32	10.29	10.15	10.19	10.28	10.33	10.32	10.40

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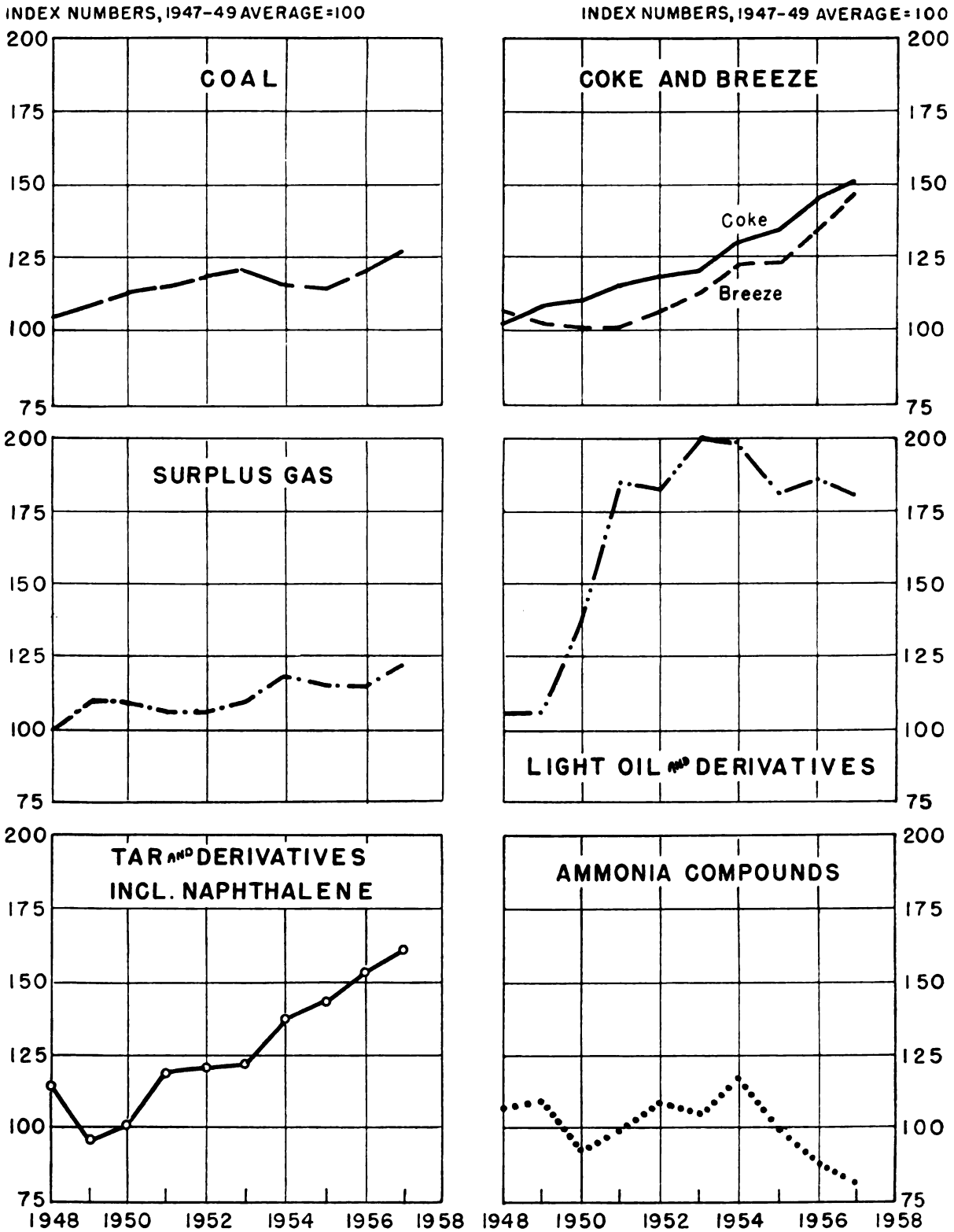

FIGURE 1.—Value of Coal, Coke, Breeze, and Coal-Chemical Materials per Ton of Coal Carbonized, 1948–57.

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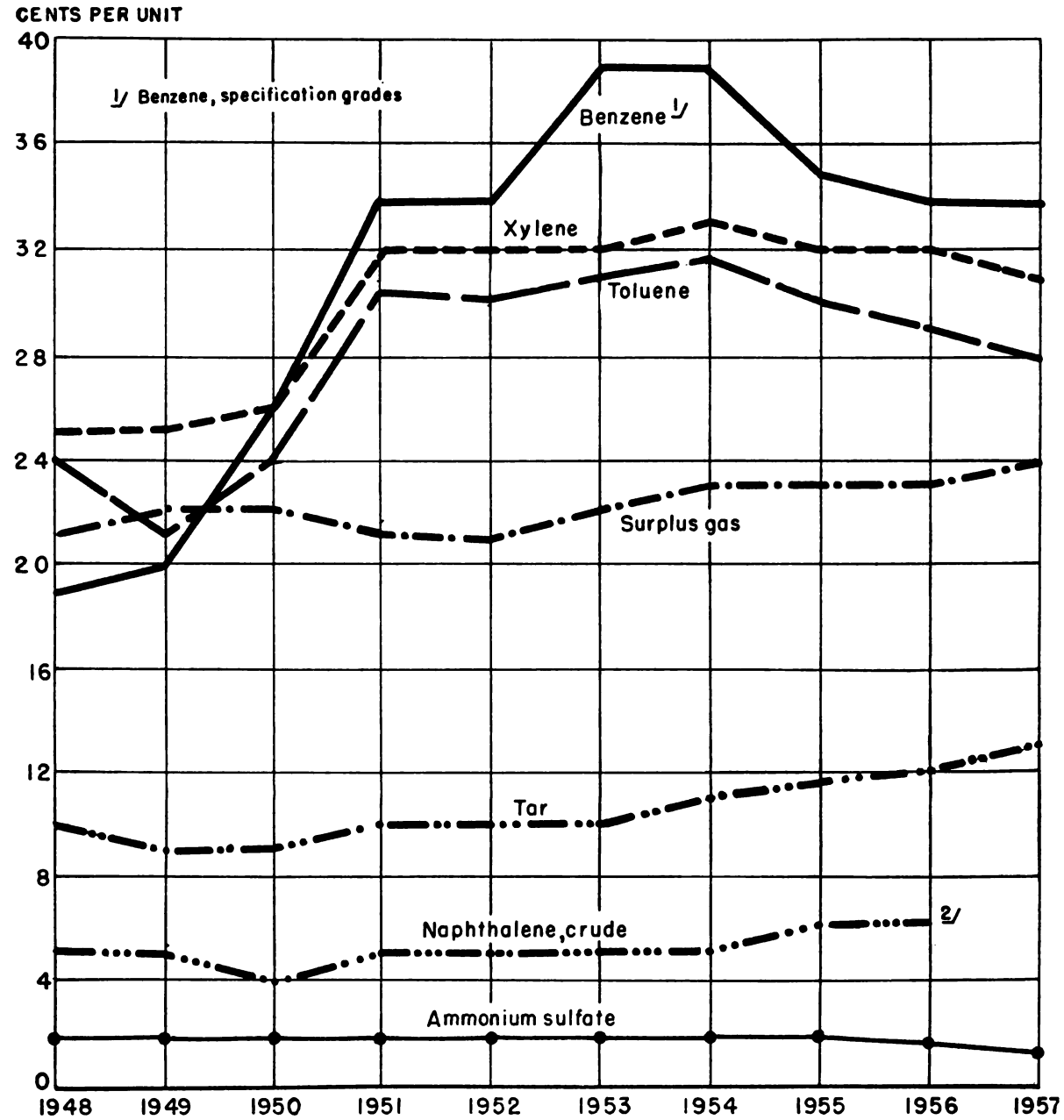
FIGURE 2.—Receipts per Unit for Principal Refined Light Oils and Other Products at Oven-Coke Plants, 1948–57.



[1] Excluded to avoid disclosing confidential company data.
[2] Figures for tar and light-oil derivatives represent cents per gallon; for sulfate and naphthalene, cents per pound; and for surplus gas, cents per thousand cubic feet.

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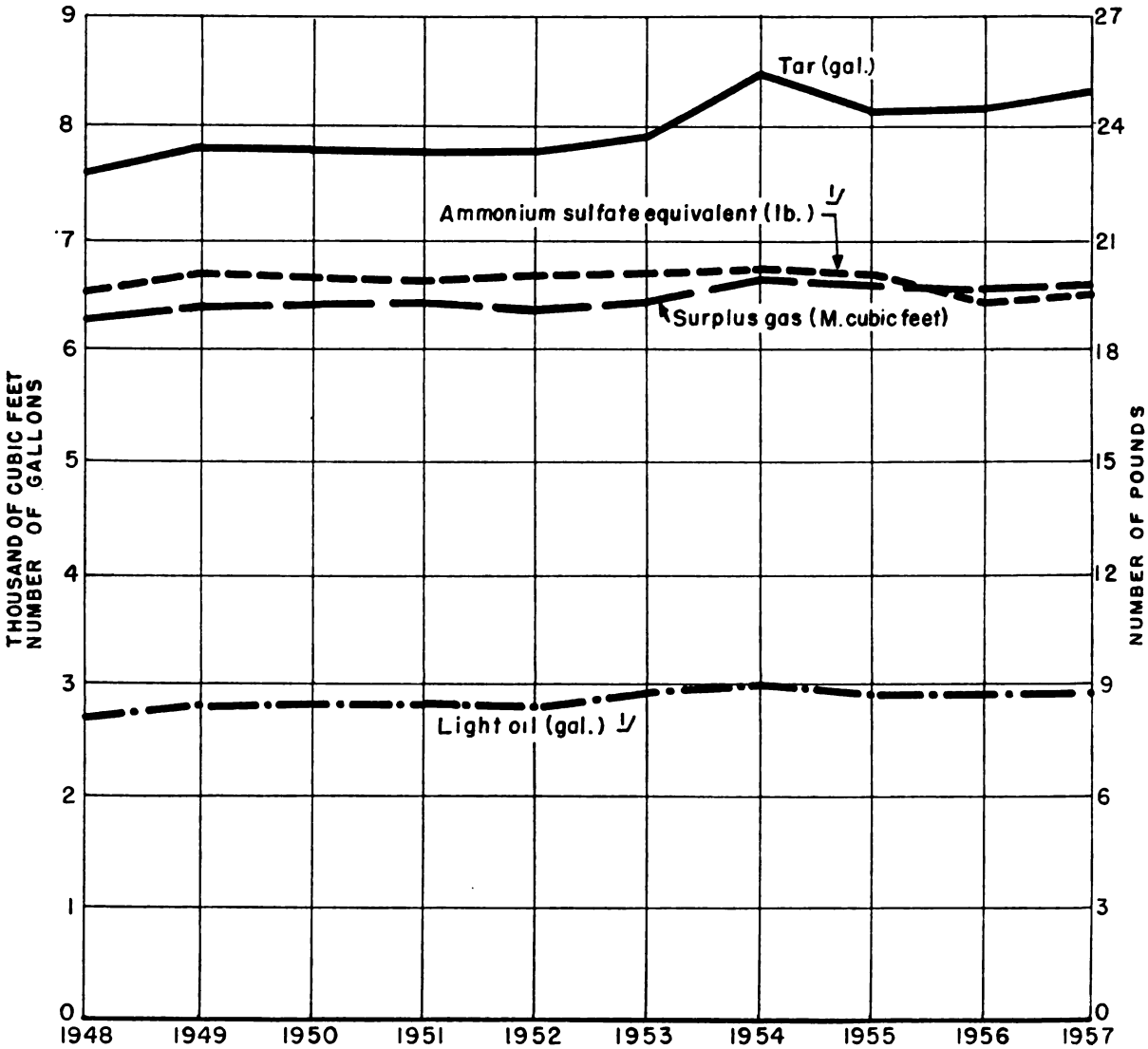
FIGURE 3.—Yield of Principal Coal-Chemical Materials per Net Ton of Coal Carbonized, 1948–57.



[1] Figures for ammonium sulfate equivalent and light oil represent average for plants recovering these products.

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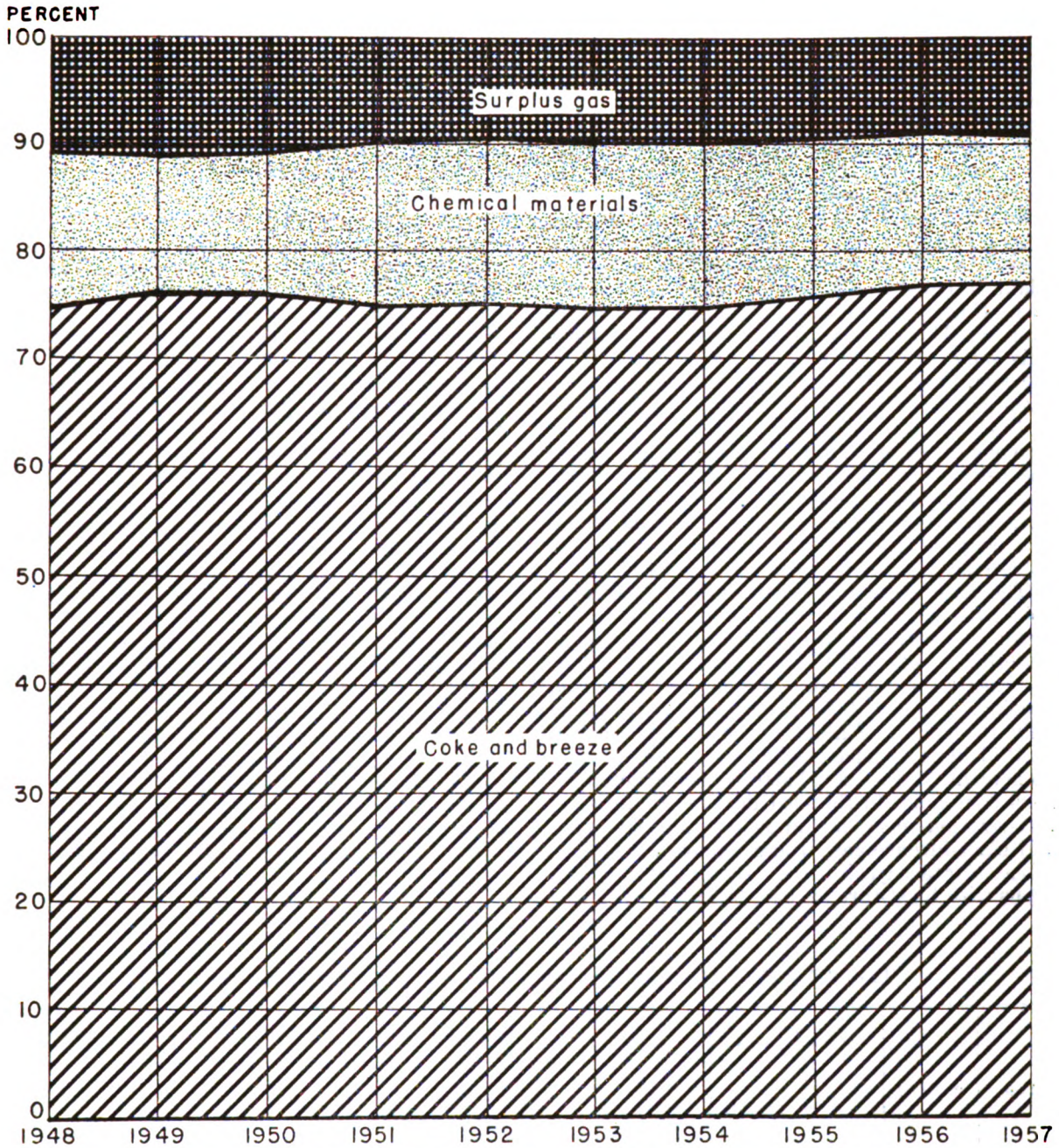

FIGURE 4.—Percentage of Total Value of Coke-Oven Products From Slot-Type Ovens Supplied by Coke and Breeze, Surplus Gas, and Chemical Materials, 1948–57.

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COKE-OVEN GAS

After removal of the basic chemical raw materials (ammonia, tar, and crude light oil), coke-oven gas remains a potential source of other chemical materials, such as hydrogen and ethylene. Until the past several years, only a minute percentage of coke-oven gas had been processed for the recovery of hydrogen. This was initiated at a coke plant operated by a large chemical company where hydrogen is used for hydrogenation of chemicals. In 1956, the first synthetic ammonia plant designed to use coke-oven gas as its source of hydrogen was built and placed in operation at Ketona, Ala. A second and larger plant using this same principle went on stream in 1957 at Geneva, Utah. Although the percentage of coke-oven gas processed for the recovery of hydrogen in 1957 was small, operating performances of these two pioneer plants in the United States can change the use pattern of coke-oven gas, if they prove that anhydrous ammonia can be produced competitively from coke-oven gas. Detailed statistics on production, yield, disposal, by uses, of coke-oven gas are shown in tables 6 to 14.

The most significant developments concerning coke-oven gas that occurred in the past decade were: (1) Increased use of blast-furnace gas for underfiring coke ovens and (2) the tremendous decrease in the use of coke-oven gas for residential heating. In 1948 blast-furnace gas represented only 10 percent of all gas used for underfiring. In 1957 blast-furnace gas had risen to more than 16 percent. Most new batteries constructed for steel companies in the past decade are designed to use various gases, including natural, coke-oven, and blast-furnace gas; where economics justifies it blast-furnace gas is used. By underfiring coke ovens with blast-furnace gas (90 B.t.u. per cubic foot), companies can use their coke-oven gas (550 B.t.u. per cubic foot) advantageously in integrated steel melting furnaces. In 1957 furnace plants used 94 percent of their surplus gas under boilers and in steel and allied plants and sold only 6 percent for residential heating and industrial purposes.

The most significant trend, however, was the decrease in use of coke-oven gas for commercial and residential heating and cooking. The volume of coke-oven gas distributed through city mains decreased 70 percent in 10 years. Whereas city gas distribution decreased, the quantity used under boilers more than doubled. The gas used in steel or allied plants increased 43 percent. According to data published by the American Gas Association, the quantity of coke-oven gas produced and purchased by gas utilities dropped from 978.6 million therms in 1948 to 348.8 million therms in 1956 (table 12). This tremendous decline of 64 percent reduced the percentage of coke-oven gas in the total manufactured gas produced and purchased by gas utilities to 24.3 percent from 34.4 percent in 1948. Although the American Gas Association did not publish comparable figures for 1957, it was apparent from the total manufactured figure published that the quantity of coke-oven gas produced and purchased by gas utilities declined from 1956.

Despite the decrease in volume of coke-oven gas sold for residential heating, which always commands higher prices than does the gas used and sold by the producers for other purposes, the value of surplus gas used and sold amounted to 46 percent of the value of all coal-chemical materials sold (table 13).

TABLE 6.—*Production and disposal of coke-oven gas, in million cubic feet*

Year	Produced	Used in heating ovens		Disposal of surplus						Wasted	
		Quantity	Percent of production	Used under boilers	Used in steel or allied plants	Distributed through city mains	Sold for industrial purposes	Total		Quantity	Percent of production
								Quantity	Percent of production		
1948	994,853	370,656	37.3	33,153	369,457	169,348	35,853	607,811	61.1	16,386	1.6
1949	882,310	324,432	36.8	27,459	329,561	154,994	34,135	546,149	61.9	11,729	1.3
1950	979,593	360,584	36.8	35,856	378,271	149,430	39,259	602,816	61.5	16,193	1.7
1951	1,052,281	380,797	36.2	42,132	428,653	137,618	44,948	653,351	62.1	18,133	1.7
1952	922,631	330,306	35.8	45,480	367,510	120,173	43,195	576,358	62.5	15,967	1.7
1953	1,069,141	374,188	35.0	53,748	480,542	99,523	39,144	672,957	62.9	21,996	2.1
1954	869,875	298,491	34.3	45,961	408,636	76,732	27,014	558,343	64.2	13,041	1.5
1955	1,083,625	373,592	34.5	57,217	523,010	70,462	38,659	689,348	63.6	20,685	1.9
1956	1,055,329	370,374	35.1	63,373	497,279	64,303	38,641	663,596	62.9	21,359	2.0
1957	1,090,846	376,405	34.5	70,673	528,492	50,948	37,247	687,360	63.0	27,081	2.5

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TABLE 7.—*Average yield of coke-oven gas per ton of coal carbonized, by States, in thousand cubic feet*

Year	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Alabama	10.12	10.22	10.18	10.17	9.42	9.46	10.07	9.99	9.94	10.09
California	11.05	11.14	11.07	11.26	11.42	11.47	11.22	11.48	10.98	[1] 11.36
Colorado	11.55	11.57	11.62	11.76	11.64	11.74	12.10	11.80	11.63	[2]
Illinois	9.87	9.72	10.02	10.01	9.94	9.91	9.87	9.98	10.16	10.08
Indiana	9.76	9.55	9.68	9.67	9.51	9.68	9.97	10.10	9.99	10.21
Maryland	10.38	10.37	10.90	10.84	10.28	10.52	10.66	10.97	10.87	11.15
Massachusetts	10.54	10.94	10.80	10.48	10.39	10.64	10.80	10.39	10.01	10.01
Michigan	10.20	10.84	10.07	10.16	9.90	9.90	9.76	9.82	9.82	10.17
Minnesota	9.99	10.02	11.28	10.41	9.93	10.51	10.76	11.07	10.91	10.97
New Jersey	10.94	11.09	10.96	11.04	11.09	10.89	10.66	10.08	10.51	10.33
New York	10.58	10.71	10.71	10.69	10.65	10.56	10.74	10.70	10.27	10.58
Ohio	9.91	10.00	9.95	10.01	10.09	10.03	10.14	10.15	10.17	10.12
Pennsylvania	10.19	10.08	10.28	10.15	10.06	10.14	10.05	10.26	10.36	10.40
Tennessee	9.60	9.97	9.22	9.18	8.88	9.28	8.80	9.16	8.98	[3] 9.57
Texas	10.73	10.68	10.80	10.91	11.30	10.93	10.72	10.72	10.40	[4]
Utah	11.69	11.62	11.75	11.98	11.61	12.09	12.62	12.04	11.46	[2]
West Virginia	10.92	10.98	11.03	10.95	11.01	11.00	10.92	10.97	11.23	11.14
Connecticut, Kentucky, Missouri, and Wisconsin	[5] 10.62	[5] 10.80	[5] 10.63	[5] 10.64	[6] 10.50	[5] 10.31	10.08	9.85	9.82	[6] 10.24
Total	10.23	10.25	10.32	10.29	10.15	10.19	10.28	10.33	10.32	10.40
At merchant plants	10.28	10.41	10.47	10.26	10.22	10.08	10.01	9.71	9.80	9.81
At furnace plants	10.22	10.21	10.29	10.30	10.13	10.21	10.31	10.42	10.40	10.47

[1] Includes Colorado and Utah.
[2] Included with California.
[3] Includes Kentucky and Texas.
[4] Included with Tennessee.
[5] Includes Rhode Island.
[6] Connecticut, Missouri, and Wisconsin.

TABLE 8.—*Production and disposal of coke-oven gas, by merchant and furnace plants, in million cubic feet*

Year	Produced		Used in heating ovens		Surplus used or sold		Wasted	
	Merchant plants	Furnace plants	Merchant plants	Furnace plants	Merchant plants	Furnace plants	Merchant plants	Furnace plants
1948	191,922	802,931	45,087	325,569	144,874	462,937	1,961	14,425
1949	176,606	705,704	40,325	284,107	135,430	410,719	851	10,878
1950	180,364	799,229	44,634	315,950	133,965	468,851	1,765	14,428
1951	187,997	864,284	50,323	330,474	134,633	518,718	3,041	15,092
1952	165,779	756,852	46,184	284,122	117,100	459,258	2,495	13,472
1953	153,561	915,580	48,450	325,738	103,154	569,803	1,957	20,039
1954	102,880	766,995	29,135	269,356	72,829	485,514	916	12,125
1955	123,131	960,494	40,258	333,334	79,258	610,090	3,615	17,070
1956	129,218	926,111	46,781	323,593	80,843	582,753	1,594	19,765
1957	118,716	972,130	44,029	332,376	73,324	614,036	1,363	25,718

TABLE 9.—*Disposal of surplus coke-oven gas, by merchant and furnace plants, in million cubic feet*

USED BY PRODUCERS UNDER BOILERS

Year	At merchant plants				At furnace plants			
	Quantity	Percent of total	Value	Average per M cubic feet	Quantity	Percent of total	Value	Average per M cubic feet
1948	6,695	1.1	$643,673	$0.096	26,458	4.3	$3,442,426	$0.130
1949	4,540	.8	496,898	.109	22,919	4.2	3,449,843	.151
1950	6,131	1.0	640,920	.105	29,725	4.9	3,799,288	.128
1951	9,331	1.4	929,113	.100	32,801	5.0	4,426,501	.135
1952	9,799	1.7	1,054,966	.108	35,681	6.2	4,884,671	.137
1953	10,687	1.6	1,365,397	.128	43,061	6.4	6,208,272	.144
1954	8,412	1.5	1,254,520	.149	37,549	6.7	6,481,054	.173
1955	12,218	1.8	2,134,910	.175	44,999	6.5	7,785,203	.173
1956	13,600	2.1	2,190,190	.161	49,773	7.5	8,135,376	.163
1957	14,023	2.0	2,593,628	.185	56,650	8.3	10,318,641	.182
USED BY PRODUCERS IN STEEL OR ALLIED PLANTS								
1948	7,109	1.2	$761,118	$0.107	362,348	59.6	$56,967,428	$0.157
1949	6,137	1.1	1,332,335	.217	323,424	59.2	53,888,004	.167
1950	6,794	1.2	1,488,564	.219	371,477	61.6	63,603,069	.171
1951	7,032	1.1	1,567,057	.223	421,621	64.5	72,257,894	.171
1952	6,701	1.2	1,435,859	.214	360,809	62.6	64,503,890	.179
1953	7,658	1.1	1,566,148	.205	472,884	70.3	92,349,449	.195
1954	6,970	1.3	1,441,279	.207	401,666	71.9	82,489,735	.205
1955	6,945	1.0	1,482,886	.214	516,065	74.9	109,969,895	.213
1956	7,848	1.2	1,785,117	.227	489,431	73.7	106,221,487	.217
1957	6,253	.9	1,412,168	.226	522,239	76.0	120,788,398	.231

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TABLE 9.—*Disposal of surplus coke-oven gas, by merchant and furnace plants, in million cubic feet*—Continued

SOLD FOR DISTRIBUTION THROUGH CITY MAINS

Year	At merchant plants				At furnace plants			
	Quantity	Percent of total	Value	Average per M cubic feet	Quantity	Percent of total	Value	Average per M cubic feet
1948	110,738	18.2	$45,866,120	$0.414	58,610	9.7	$12,363,770	$0.211
1949	103,589	19.0	45,530,189	.440	51,405	9.4	11,557,777	.225
1950	102,583	17.0	45,136,943	.440	46,847	7.8	11,367,781	.243
1951	98,285	15.1	41,356,625	.421	39,333	6.0	10,493,883	.267
1952	83,539	14.5	34,452,421	.412	36,634	6.3	9,842,740	.269
1953	67,193	10.0	29,895,570	.445	32,330	4.8	9,116,086	.282
1954	45,926	8.2	22,635,476	.493	30,806	5.5	8,717,173	.283
1955	41,450	6.0	21,198,502	.511	29,012	4.2	6,559,162	.226
1956	39,914	6.0	20,215,765	.506	24,389	3.7	6,068,285	.249
1957	34,555	5.0	17,790,527	.515	16,393	2.4	4,747,010	.290
SOLD FOR OTHER INDUSTRIAL USES								
1948	20,332	3.3	$3,399,481	$0.167	15,521	2.6	$2,111,980	$0.136
1949	21,165	3.9	3,241,530	.153	12,970	2.4	1,882,256	.145
1950	18,457	3.1	2,858,061	.155	20,802	3.4	3,353,030	.161
1951	19,984	3.1	3,245,591	.162	24,964	3.8	4,023,635	.161
1952	17,060	3.0	2,586,101	.152	26,135	4.5	4,221,465	.162
1953	17,617	2.6	3,118,718	.177	21,527	3.2	4,107,716	.191
1954	11,521	2.1	2,039,737	.177	15,493	2.8	3,506,940	.226
1955	18,644	2.7	3,148,164	.169	20,015	2.9	3,861,044	.192
1956	19,482	2.9	3,189,753	.164	19,159	2.9	3,675,677	.192
1957	18,493	2.7	3,122,043	.169	18,754	2.7	3,985,211	.212

TABLE 10.—*Disposal of surplus coke-oven gas, in percent*

Year	Surplus gas (million cubic feet)	Disposal			
		Distributed through city mains	In steel or allied plants	Under boilers or other coke-plant equipment	Sold for industrial use
1948	607,811	27.9	60.8	5.4	5.9
1949	546,149	28.4	60.3	5.0	6.3
1950	602,816	24.8	62.8	5.9	6.5
1951	653,351	21.1	65.6	6.4	6.9
1952	576,358	20.8	63.8	7.9	7.5
1953	672,957	14.8	71.4	8.0	5.8
1954	558,343	13.7	73.2	8.2	4.9
1955	689,348	10.2	75.9	8.3	5.6
1956	663,596	9.7	74.9	9.6	5.8
1957	687,360	7.4	76.9	10.3	5.4

TABLE 11.—*Disposal pattern of coke-oven gas per ton of coal carbonized, in thousand cubic feet*

Year	Surplus used or sold	Burned in coking process	Wasted	Total
1948	6.25	3.81	0.17	10.23
1949	6.35	3.77	.13	10.25
1950	6.35	3.80	.17	10.32
1951	6.39	3.72	.18	10.29
1952	6.34	3.63	.18	10.15
1953	6.41	3.57	.21	10.19
1954	6.60	3.53	.15	10.28
1955	6.57	3.56	.20	10.33
1956	6.49	3.62	.21	10.32
1957	6.55	3.59	.26	10.40

TABLE 12.—*Manufactured gas produced and purchased by gas utilities, by kinds of gas, in million therms* [1]

Year	Carbureted water gas [2]	Coke-oven gas	Retort-coal gas	Oil and oil-refining gas	Total	Percent of coke-oven gas
1948	1,637.7	978.6	52.0	179.7	2,848.0	34.4
1949	1,573.1	891.2	35.2	181.8	2,681.3	33.2
1950	1,611.3	860.5	20.9	166.3	2,659.0	32.4
1951	1,473.9	775.3	15.4	170.0	2,434.6	31.8
1952	1,159.5	688.8	6.0	154.9	2,009.2	34.3
1953	1,012.3	603.0	(3)	141.0	1,756.3	34.3
1954	968.9	437.6	(3)	97.8	1,504.3	29.1
1955	1,075.8	396.8	(3)	98.5	1,571.1	25.3
1956	1,005.0	348.8	(3)	79.7	1,433.5	24.3
1957	(4)	(4)	(4)	(4)	1,166.7	[5] 24.0

[1] American Gas Association, Gas Facts, 1956 and 1957 editions.
[2] Includes reformed natural, reformed liquefied petroleum gases, and liquefied petroleum and natural gases used for enriching.
[3] Included in coke-oven gas.
[4] Not available.
[5] Estimated.

TABLE 13.—*Relationship of value of surplus gas used or sold by coke-plant operators to value of all coal-chemical materials sold*

Year	Value of surplus gas used or sold	Value of all coal-chemical materials sold [1]	Percent of surplus gas
1948	$125,555,996	$267,126,556	47.0
1949	121,378,332	238,720,731	50.8
1950	132,247,656	274,370,150	48.2
1951	138,300,299	323,947,957	42.7
1952	122,982,113	289,240,761	42.5
1953	147,727,356	346,519,393	42.6
1954	128,565,914	292,243,755	44.0
1955	156,139,766	348,379,639	44.8
1956	151,481,650	341,628,908	44.3
1957	164,757,626	357,772,272	46.1

[1] Includes surplus gas used as well as that sold.

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TABLE 14.—*Gas used to heat coke ovens, by kinds, in million cubic feet* [1]

Year	Coke-oven gas		Producer gas		Blue-water gas		Blast-furnace gas		Other gases [2]		Total coke-oven gas equivalent
	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	
1948	370,656	81.3	30,305	6.7	1,934	0.4	45,698	10.0	7,455	1.6	456,048
1949	324,432	83.0	27,319	7.0	1,866	.5	29,996	7.7	7,007	1.8	390,620
1950	360,584	83.7	25,298	5.9	1,940	.4	36,889	8.6	5,849	1.4	430,560
1951	380,797	83.5	21,231	4.7	1,329	.3	42,098	9.2	10,344	2.3	455,799
1952	330,306	82.5	16,219	4.0	1	--------	42,100	10.5	11,986	3.0	400,612
1953	374,188	83.3	14,458	3.2	20	--------	53,199	11.9	7,059	1.6	448,924
1954	298,491	79.7	11,351	3.0	156	.1	56,370	15.1	7,954	2.1	374,322
1955	373,592	80.5	7,832	1.7	10	--------	75,010	16.2	7,283	1.6	463,727
1956	370,374	81.7	5,675	1.2	--------	--------	70,558	15.6	6,687	1.5	453,294
1957	376,405	81.3	3,460	.7	871	.2	75,331	16.3	6,822	1.5	462,889

[1] Corrected to 550 B.t.u. per cubic foot.
[2] Butane, liquefied petroleum, natural, oil, propane, and spillage gases.

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COKE-OVEN TAR

High-temperature, slot-type coke ovens supply all but an insignificant quantity of the coal tar produced in the United States. Considerable quantities of crude coal tar were made in coal-gas retorts until the late 1940's, but this source of supply is no longer available, as no coal-gas retorts were active in 1957. Several small, low-temperature carbonization plants operated in 1957, but production data are withheld to prevent disclosing individual company figures (table 15).

Production of coke-oven tar during the period under review increased at an average rate of 2 percent per year (table 16). This upward trend in tar output was due in part to improved yields since 1954, as well as to increased carbonizing capacity. Of the four basic coal-chemical materials recovered at coke plants (tar, ammonia, crude light oil, and gas) tar yields showed greater improvement than the others. The 8.46 gallons per ton of coal carbonized in 1954 was the highest for the 10 years under review but was far less than the record of 9.84 established in 1932 (table 17). The yield of tar varies widely among the various coke plants, depending on the rank and grade of coal carbonized, the oven temperature, the completeness of tar recovery, and other factors. Yield of tar among plants ranges from 4 to 11 gallons per ton of coal. Table 17 shows that the high-volatile coals usually produce higher tar yields than medium- and low-volatile coals, which accounts for the high tar yields in California, Colorado, Utah, and West Virginia. The yield of tar was lowest in Indiana, where nearly 50 percent of the coal carbonized was low-volatile.

There were only minor variations in the utilization pattern of coke-oven tar in 1948–57. Depending on economic conditions, crude tar may be utilized as fuel, or it may be processed to make various tar products. The use of crude tar as fuel declined slightly, whereas the proportion of crude tar processed by producing companies advanced slightly. In 1948, 23 percent of the crude tar production was used as fuel, less than 1 percent for miscellaneous industrial purposes (road maintenance, pipe coatings, tarring ingot molds), and the remainder (76 percent) was processed. Of this percentage, 26 percent was processed by producing companies, and 50 percent was sold to tar distillers (table 16). In 1957 the proportion used as fuel was only 20 percent of the total production, and more than 80 percent was processed. The proportion of tar processed by producers was only 30 percent of the total in 1957, compared with 37 percent in 1955. This decline was caused by the sale of tar-refining facilities at two coke plants to commercial tar-refining companies in 1957. Most of the tar processed by producers is only partially refined or "topped." In topping tar producers recover and market the distillate fractions (tar acids, bases, and naphthalene) and burn the residual tar or pitch. Approximately 60 percent of the tar processed annually by producers in the past decade was topped. Tables 18–19 show the quantities of tar processed by coke-plant operators and tar derivatives obtained.

The principal tar derivatives made at coke plants are creosote oil, crude chemical oil (tar-acid oil), naphthalene, and pitch. The production of creosote has varied from year to year, but there was no upward trend in production. On the other hand, the production of crude chemical oil increased substantially and in 1957 was almost double the quantity produced in 1948. Crude tar contains, roughly, 5 to 12 percent naphthalene, and coke plants that process tar for recovery of naphthalene in past years have averaged about 1 pound of crude naphthalene per gallon of tar processed. In addition to recovering naphthalene from tar, coke-plant operators also recovered it in refining crude light oil and, to a smaller extent, from final coolers. Before 1930 most crude naphthalene produced at coke plants was obtained from refining crude light oil and was therefore included with light oil and its derivatives. Beginning in the late 1920's, construction of tar-processing facilities at coke plants increased the quantity of naphthalene recovered from tar, and by 1950 nearly 50 percent of production at coke plants was obtained from processing tar.

The installation of several tar-processing plants, designed especially for naphthalene recovery, in the mid-1950's increased the production from tar, and since 1954 it is estimated that more than three-fourths of all naphthalene recovered at coke plants was obtained from tar. Consequently, in this report naphthalene data were removed from those for light oil and its derivatives and are included with tar products. Beginning in 1957, however, publication of statistics on creosote oil, naphthalene, and phenol produced at coke plants was discontinued to avoid disclosing individual company figures because of the change in ownership of two tar-processing plants (see previous paragraph).

In processing crude tar, approximately 50 to 80 percent of the tar is recovered as pitch, depending on the distillation temperatures employed. Most of the pitch produced is a residual tar and is used as fuel. In recent years, however, several plants that process tar have made pitch to meet

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certain specifications and have marketed small quantities as roofing material and for other industrial applications. This raised the quantity marketed from less than 4,000 tons to almost 94,000 tons in 1955. In 1957, approximately 65,000 tons was sold at an average value of $29.45 per ton.

The average price of creosote oil increased slightly during the 10 years, ranging from an average of $0.156 per gallon in 1950 to $0.196 in 1956; naphthalene prices increased from $0.043 per pound in 1950 to $0.061 in 1956; crude chemical oil dropped slightly, while pitch fluctuated between $22.92 per ton in 1950 and $29.86 in 1948.

TABLE 15.—*Production of crude coal tar from all sources, in gallons*

Year	Coke-oven tar	Retort, medium- and low-temperature tar	Total	Percent from coke ovens
1948	738,755,106	14,304,871	753,059,977	98.1
1949	672,407,370	11,055,974	683,463,344	98.4
1950	739,868,767	4,355,918	744,224,685	99.4
1951	795,311,283	2,923,900	798,235,183	99.6
1952	703,889,653	915,117	704,804,770	99.9
1953	828,728,761	4,787,244	833,516,005	99.4
1954	715,840,473	5,052,396	720,892,869	99.3
1955	852,922,817	[1]	852,922,817	100.0
1956	832,827,042	[1]	832,827,042	100.0
1957	873,474,352	[1]	873,474,352	100.0

[1] Not published.

TABLE 16.—*Coke-oven tar produced, used by producers, and sold, in thousand gallons*

Year	Produced	Used by producer					Sold			
		Burned		Refined		Otherwise	For refining		As fuel	
		Quantity	Percent of production	Quantity	Percent of production		Quantity	Percent of production	Quantity	Percent of production
1948	738,755	137,721	18.6	194,235	26.3	2,342	367,730	49.8	34,677	4.7
1949	672,407	140,361	20.9	166,669	24.8	2,348	338,905	50.4	27,520	4.1
1950	739,869	97,893	13.2	203,320	27.5	2,842	403,928	54.6	31,318	4.2
1951	795,311	108,436	13.6	252,292	31.7	2,068	424,109	53.3	14,624	1.8
1952	703,890	109,400	15.5	219,892	31.2	2,758	371,956	52.8	5,192	.7
1953	828,729	127,333	15.4	254,448	30.7	2,373	431,513	52.1	16,991	2.1
1954	715,840	146,783	20.5	218,169	30.5	2,416	355,879	49.7	----------	----------
1955	852,923	137,062	16.1	311,675	36.5	1,544	398,380	46.7	----------	----------
1956	832,827	138,425	16.6	285,805	34.3	1,398	416,286	50.0	----------	----------
1957	873,474	172,893	19.8	258,365	29.6	3,281	441,989	50.6	----------	----------

TABLE 17.—*Average yield of coke-oven tar per ton of coal carbonized, by States, in gallons*

State	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Alabama	7.89	7.87	7.77	7.59	7.05	7.24	7.93	7.59	7.61	7.73
California	9.89	9.96	9.99	9.89	9.45	9.30	9.18	9.13	8.98	[1] 9.85
Colorado	9.54	9.38	9.30	9.54	9.40	9.56	10.02	10.55	10.60	([2])
Illinois	6.45	6.69	6.74	6.62	6.67	6.91	7.20	7.01	6.70	7.37
Indiana	5.50	5.67	5.81	6.02	6.09	5.97	6.15	5.43	5.71	6.31
Maryland	7.44	7.49	7.86	7.85	7.78	8.11	8.37	8.56	8.63	8.64
Massachusetts	6.76	7.40	7.75	7.58	7.52	7.95	8.49	8.13	7.82	7.68
Michigan	6.97	7.10	6.79	6.68	6.73	6.62	7.18	7.58	7.46	7.86
Minnesota	5.67	6.10	6.75	6.73	6.90	7.42	7.29	7.23	7.18	7.24
New Jersey	7.52	7.78	8.08	8.10	8.06	7.95	8.49	8.01	7.39	7.76
New York	7.74	7.97	7.88	7.83	7.47	7.94	8.24	7.71	7.88	8.07
Ohio	6.64	7.06	7.09	7.32	7.41	7.52	8.08	7.67	7.61	7.71
Pennsylvania	8.88	9.02	8.99	8.84	8.99	9.23	9.96	9.66	9.59	9.66
Tennessee	7.34	7.12	7.17	7.32	6.90	7.13	8.17	7.84	7.49	[3] 7.01
Texas	6.55	6.72	6.57	6.39	5.95	5.67	6.63	6.20	6.09	([4])
Utah	10.32	10.42	10.76	10.69	9.65	9.55	10.35	10.17	9.87	([5])
West Virginia	9.96	10.22	9.23	9.16	9.22	9.03	10.25	9.79	9.99	10.11
Connecticut, Kentucky, Missouri, and Wisconsin	[6] 7.11	[6] 7.37	[6] 7.44	[6] 7.27	[6] 7.25	[6] 7.17	7.76	7.32	7.18	[6] 6.42
Total	7.60	7.81	7.79	7.78	7.74	7.90	8.46	8.13	8.15	8.32
At merchant plants	7.65	7.84	7.88	7.65	7.61	7.60	7.80	7.28	7.18	7.20
At furnace plants	7.59	7.81	7.78	7.80	7.77	7.95	8.55	8.25	8.29	8.47

[1] Includes Colorado and Utah.
[2] Included with California.
[3] Includes Kentucky and Texas.
[4] Included with Tennessee.
[5] Includes Rhode Island.
[6] Connecticut, Missouri, and Wisconsin.

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TABLE 18.—*Coke-oven tar refined by producers and creosote oil, crude chemical oil, and pitch-of-tar recovered*

Year	Tar refined, in thousand gallons [1]	Creosote oil, in thousand gallons			Crude chemical oil, in thousand gallons			Pitch-of-tar in net tons		
		Produced	Sold		Produced	Sold		Produced	Sold	
			Quantity	Average value per gallon		Quantity	Average value per gallon		Quantity	Average value per ton
1948	194,235	34,985	33,039	$0.179	14,553	14,773	$0.291	636,915	3,394	$29.862
1949	166,669	24,379	23,513	.179	12,247	11,885	.298	539,801	13,768	23.788
1950	203,320	37,710	34,883	.156	17,711	17,967	.238	715,711	24,502	22.915
1951	252,292	42,972	39,311	.179	24,897	23,851	.275	846,436	42,198	24.637
1952	219,892	39,422	38,843	.176	20,404	20,460	.280	746,355	43,658	25.335
1953	254,448	37,326	36,944	.189	24,812	23,691	.259	881,170	55,528	27.774
1954	218,169	26,470	25,648	.191	23,087	23,522	.210	751,081	42,847	29.328
1955	311,675	31,019	30,823	.194	26,919	27,181	.242	1,122,739	93,696	25.492
1956	285,805	28,429	29,514	.196	26,311	26,136	.265	1,025,509	88,964	28.051
1957	258,365	[2]	[2]	[2]	26,217	27,238	.265	925,004	65,003	29.452

[1] Includes tar topped.
[2] Withheld to avoid disclosing individual company figures.

TABLE 19.—*Crude naphthalene produced and sold by coke-plant operators, in pounds*

Year	Produced	Sold			Value per ton of coal carbonized
		Quantity	Value		
			Total	Average	
1948	103,431,811	100,442,631	$4,619,374	$0.046	$0.048
1949	70,823,436	56,643,829	2,654,815	.047	.031
1950	99,729,587	102,657,724	4,425,894	.043	.047
1951	125,579,578	130,200,785	6,849,831	.053	.067
1952	106,903,506	96,457,812	4,961,657	.051	.055
1953	112,937,214	91,542,111	4,387,426	.048	.042
1954	100,059,031	97,301,871	4,369,262	.045	.052
1955	184,223,038	173,788,784	9,535,172	.055	.091
1956	177,258,882	135,928,863	8,271,978	.061	.081
1957	[1]	[1]	[1]	[1]	[1]

[1] Withheld to prevent disclosing individual company figures.

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COKE-OVEN CRUDE LIGHT OIL AND DERIVATIVES

Crude light oil is the chemical raw material from which benzene, toluene, xylene, solvent naphtha, and other products are made. In the early days of the industry the usual practice was to include as light oil all materials distilled up to 200° C. In modern light-oil refining plants only material distilled up to 150° to 155° C. is classified as light oil, and a secondary fraction distilling between 150° and 200° C. is separated. This secondary fraction, known as intermediate light oil, contains about 50 percent of polymerizable materials, coumarone, indene, and dicyclopentadiene. The remainder is mainly polyalkylbenzene and naphthalene. Intermediate light oil is generally sold by coke-plant operators to tar distillers for the recovery of coumarone, indene, resins, solvents, shingle stains. Production and yield of crude light oil are shown in tables 20 and 21 and derivatives obtained in tables 22–24.

Crude light oil is generally refined by producers, and only about 5 percent is sold to commercial tar distillers (table 20). In refining crude light oil, about 60 to 65 percent is recovered as benzene, 12 to 14 percent as toluene, 3 to 4 percent as xylene, and 2 to 3 percent as solvent naphtha; 2 to 3 percent is made into other salable products (table 23).

Virtually all benzene produced at coke plants is made to meet definite established specifications and is used in the chemical industry. Production of these principal commercial grades, which are classified as specification grades, is shown in table 24. The production of motor benzene dropped to a small figure in recent years. In the 10-year period under review the highest output of motor benzene occurred in 1949, when almost 21 million gallons was produced at coke plants. The cutback in the Government synthetic rubber program and a slump in business conditions that year reduced requirements for specification grades, and some coke-plant operators had to make Motor grade in order to sell their benzene. This condition lasted only a short time, because the synthetic rubber plants were reactivated in 1950 and outbreak of war in Korea increased benzene requirements sharply, and coke ovens could not meet demands for benzene. Consequently, benzene-producing facilities were constructed at petroleum refineries, and increasing quantities of specification grades of benzene were made from crude-petroleum fractions. Table 25 shows the production of benzene by coke-plant operators, tar distillers, and petroleum refiners during the past 10 years. The production of benzene by tar distillers fluctuated widely because most benzene made at these plants is derived from imported material. The quantity of crude benzene imported during the period under review was governed by demand or requirements of pure benzene by the chemical industry and varied widely. Production of benzene at coke plants showed a slight increase, while output at petroleum refineries went from less than a million gallons to more than 116 million by 1957, which equaled 35 percent of all specification grades of benzene in the United States. In the 10-year period the proportion of benzene made at coke plants to total United States production dropped from 92 to 54 percent in 1957.

In recent years and particularly since 1954, an increasing proportion of benzene imported into this country has been pure which does not require further refining or upgrading. This pure benzene, therefore, is not included in the statistics published by the United States Tariff Commission on benzene produced by tar distillers. These statistics include only benzene made by refining or upgrading imported crude benzene or light oil. Although the Tariff Commission's data are accurate and represent all commercial benzene produced in the United States, they do not represent the total available supply. In an attempt to determine the approximate supply of benzene in the United States for the period under review, the authors have prepared table 26 based on data previously published by various governmental agencies. Data on benzene produced at coke plants were obtained from statistics published by the Bureau of Mines and for petroleum refiners from data published by the United States Tariff Commission. For production by tar distillers, an average of 1953–54 data published by the Chemical and Rubber Division, Business and Defense Services Administration, was used to estimate the approximate production of commercial benzene from domestic crude material. The approximate supply of pure benzene from imported crude was estimated at 90 percent of the total imports as published by the Bureau of the Census, U.S. Department of Commerce. Although the figures in table 26 on available supply may not be precise for each year, they are believed to be accurate enough to indicate trends.

Although no significant new uses were developed for benzene for the years under review, benzene requirements for some major uses markedly increased. The American Coke and Coal Chemicals Institute in recent years has prepared annual estimates on consumption of benzene by uses. Table 27 shows these estimates. Although these figures were only estimates, they agree closely with data obtained in special surveys by the Business and Defense Services Administration,

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U.S. Department of Commerce, in 1950–51 and in 1953–54. These figures are considered accurate enough to indicate trends in the major markets.

Production data on coke-oven toluene, by grades, are shown in table 24. Coke ovens supplied only 19 percent of the national output of this chemical in 1957, as the bulk was derived from petroleum fractions. Xylene, another solvent formerly made exclusively from coal carbonization, now is obtained largely from petroleum processing. Only 9 percent of the total for the last 5 years was obtained from coal.

TABLE 20.—*Coke-oven crude light oil produced, refined, and derived products obtained, in gallons*

Year	Produced	Refined on premises	Derived products obtained
1948	256,089,065	242,956,216	208,551,063
1949	228,754,333	220,888,075	190,720,203
1950	260,856,875	244,872,337	213,746,380
1951	284,496,933	270,541,072	234,308,450
1952	249,283,837	237,312,046	204,600,586
1953	295,725,435	278,905,871	237,100,301
1954	246,018,627	233,983,106	194,759,732
1955	297,497,792	281,200,190	235,576,183
1956	290,972,209	276,765,214	234,228,862
1957	301,088,346	289,437,715	244,258,357

TABLE 21.—*Average yield of coke-oven crude light oil per ton of coal carbonized, by States, in gallons*

State	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Alabama	2.76	2.80	2.73	2.60	2.46	2.51	2.69	2.56	2.62	2.64
California	3.75	3.43	3.25	3.29	3.12	2.80	3.40	3.34	3.37	[1] 3.46
Colorado	3.08	3.13	2.89	3.16	3.38	3.53	3.65	3.64	3.65	([2])
Illinois	2.50	2.43	2.44	2.58	2.65	2.66	2.75	2.76	2.79	2.91
Indiana	2.25	2.30	2.45	2.40	2.31	2.74	2.70	2.23	2.42	2.54
Maryland	3.89	3.92	4.08	3.32	3.32	3.20	3.14	3.45	3.43	3.41
Massachusetts	([3])	([3])	([3])	([3])	([3])	2.98	2.85	2.84	2.74	2.55
Michigan	2.61	2.42	2.51	2.47	2.57	2.51	2.86	2.80	2.72	2.78
New Jersey	([3])	([3])	([3])	([3])	([3])	2.59	3.02	2.87	2.62	2.55
New York	2.54	2.59	2.66	2.80	2.80	3.10	3.06	2.99	3.15	3.16
Ohio	2.58	2.79	2.82	2.93	2.95	2.93	2.93	2.83	2.85	2.83
Pennsylvania	3.04	2.97	3.09	3.05	3.03	3.02	3.16	3.21	3.14	3.14
Tennessee	2.58	2.70	2.66	2.59	2.46	2.63	2.90	2.52	2.39	[4] 2.77
Texas	2.63	2.77	2.41	2.56	2.44	2.51	2.75	2.75	2.70	([5])
Utah	3.53	3.78	3.93	3.91	3.54	3.72	3.82	3.68	3.61	([6])
West Virginia	2.93	3.02	3.13	3.17	3.05	3.14	3.05	3.02	3.02	3.00
Connecticut, Kentucky, Missouri, and Wisconsin	[7] 1.92	[7] 2.19	[7] 1.84	[7] 2.25	[7] 2.16	2.43	2.65	2.66	2.56	[7] 2.20
Total	2.73	2.77	2.81	2.82	2.79	2.90	2.98	2.91	2.92	2.94
At merchant plants	2.16	2.29	2.24	2.27	2.21	2.51	2.63	2.51	2.49	2.46
At furnace plants	2.85	2.87	2.93	2.94	2.91	2.96	3.03	2.96	2.98	2.99

[1] Includes Colorado and Utah.
[2] Included with California.
[3] Included with Connecticut, Kentucky, Missouri, and Wisconsin.
[4] Includes Kentucky and Texas.
[5] Included with Tennessee.
[6] Includes Massachusetts, Minnesota, and New Jersey.
[7] Connecticut, Missouri, and Wisconsin.

TABLE 22.—*Light-oil derivatives produced at oven-coke plants, in gallons*

Year	Benzene		Toluene, all grades	Xylene, all grades	Solvent naphtha, crude and refined	Other light-oil derivatives
	Motor	All other grades				
1948	9,014,336	149,998,882	28,448,259	7,285,338	5,742,697	8,061,571
1949	20,923,704	122,741,464	27,670,579	7,264,642	4,997,062	7,122,783
1950	7,727,349	154,466,388	30,664,831	8,066,942	6,002,849	6,815,081
1951	5,103,677	172,849,275	34,301,508	9,097,044	6,036,302	6,920,644
1952	([1])	155,114,327	30,522,451	8,093,761	4,681,057	6,188,900
1953	1,160,043	177,592,765	36,036,486	9,928,224	6,285,346	6,097,427
1954	3,827,096	139,437,786	33,383,028	9,956,303	4,582,782	4,072,737
1955	([1])	174,220,342	38,205,443	11,294,085	5,511,382	6,344,981
1956	([1])	174,426,023	37,238,064	10,339,817	5,824,619	6,400,339
1957	1,834,263	179,252,295	37,985,093	10,793,389	6,278,251	8,115,066

[1] Included with "Other light-oil derivatives" to avoid disclosing individual company figures.

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TABLE 23.—*Yield of light-oil products from refining crude light oil at oven-coke plants, in percent*

Year	Benzene		Toluene, all grades	Xylene, all grades	Solvent naphtha, crude and refined	Other light-oil products	Yield of salable products
	Motor	All other grades					
1948	3.7	61.7	11.7	3.0	2.4	3.3	85.8
1949	9.5	55.6	12.5	3.3	2.3	3.2	86.4
1950	3.2	63.1	12.5	3.3	2.5	2.8	87.4
1951	1.9	63.9	12.7	3.4	2.2	2.6	86.7
1952	.2	65.4	12.9	3.4	2.0	2.4	86.3
1953	.4	63.7	12.9	3.6	2.2	2.2	85.0
1954	1.4	59.6	14.3	4.3	2.0	1.7	83.3
1955	.4	62.0	13.6	4.0	2.0	1.8	83.8
1956	.4	63.0	13.5	3.7	2.1	1.9	84.6
1957	.6	61.9	13.1	3.7	2.2	2.8	84.3

TABLE 24.—*Benzene and toluene produced at oven-coke plants, by grades, in gallons*

Year	Benzene				Toluene		
	Motor	Nitration or 1° C.	Industrial pure or 2° C.	All other	Nitration or 1° C.	Industrial pure or 2° C.	All other
1948	9,014,300	43,541,200	103,356,300	3,101,400	22,899,700	5,280,800	267,800
1949	20,923,700	28,988,700	91,717,300	2,035,600	20,808,300	6,317,200	545,100
1950	7,727,300	41,324,900	110,114,300	3,027,200	22,108,600	7,785,800	770,400
1951	5,103,700	45,057,500	123,315,700	4,476,100	24,772,500	8,689,700	839,300
1952	[1]	46,211,300	104,030,800	4,872,200	21,342,000	7,613,400	1,567,100
1953	1,160,000	51,566,400	120,939,500	5,086,900	26,834,400	8,330,500	871,600
1954	3,327,100	44,383,000	92,336,600	2,718,200	24,718,800	7,775,600	888,600
1955	[1]	87,642,000	84,125,700	2,452,600	30,037,900	8,167,500	[2]
1956	[1]	74,312,800	97,393,000	2,720,200	29,673,600	7,564,500	[2]
1957	1,834,300	88,262,900	79,421,900	11,567,500	30,716,800	7,268,300	[2]

[1] Withheld to avoid disclosing individual company figures.
[2] Combined with "Industrial pure or 2° C." to avoid disclosing individual company figures.

TABLE 25.—*Production of benzene (excluding Motor grade), in thousand gallons* [1]

Year	From tar distilleries [3]					From coke-oven operations				
	Produced	Percent of total	Sold			Produced	Percent of total	Sold		
			Quantity	Value				Quantity	Value	
				Total	Average				Total	Average
1948	[3] 13,192	8.1	7,028	$1,591	$0.23	149,999	91.9	149,124	$28,758	$0.19
1949	10,517	7.9	5,323	1,236	.23	122,741	92.1	122,796	24,368	.20
1950	21,557	11.6	14,763	4,153	.28	154,466	83.0	150,957	38,513	.26
1951	60,310	22.7	45,422	17,081	.38	172,849	65.0	171,024	57,589	.34
1952	61,035	24.3	37,489	18,552	.49	155,114	61.6	152,859	51,870	.34
1953	32,106	11.8	19,224	8,496	.44	177,593	65.1	172,405	66,479	.39
1954	25,460	9.9	18,344	7,413	.40	139,438	54.3	131,857	50,958	.39
1955	34,671	11.3	24,948	7,970	.32	174,220	56.6	168,750	58,663	.35
1956	50,551	15.0	34,698	10,377	.30	174,426	51.8	173,420	59,548	.34
1957	36,112	10.9	24,787	8,911	.36	179,252	54.1	171,944	59,080	.34

Year	From petroleum refineries					Total				
	Produced	Percent of total	Sold			Produced	Percent of total	Sold		
			Quantity	Value				Quantity	Value	
				Total	Average				Total	Average
1948	[4]	[4]	[4]	[4]	[4]	163,191	100.0	156,152	$30,349	$0.19
1949	[4]	[4]	[4]	[4]	[4]	133,258	100.0	128,119	25,604	.20
1950	10,129	5.4	6,802	$2,475	$0.36	186,152	100.0	172,522	45,141	.26
1951	32,572	12.3	17,589	8,280	.47	265,731	100.0	234,035	82,950	.35
1952	35,518	14.1	26,650	12,788	.48	251,667	100.0	216,998	83,210	.38
1953	63,043	23.1	41,071	20,790	.51	272,744	100.0	232,700	95,765	.41
1954	91,912	35.8	51,714	24,631	.48	256,810	100.0	201,915	83,002	.41
1955	98,588	32.1	71,110	30,901	.43	307,479	100.0	264,808	97,534	.37
1956	111,618	33.2	76,331	32,834	.43	336,590	100.0	284,449	102,759	.36
1957	116,184	35.0	79,773	29,991	.38	331,548	100.0	276,504	97,982	.35

[1] U.S. Tariff Commission.
[2] Includes benzene made from imported crude light oil.
[3] Includes some material produced from petroleum.
[4] Included with benzene from tar distilleries.

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TABLE 26.—*Estimated supply of specification grades of benzene (excluding Motor grade), in thousand gallons*

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Production from domestic crude material:										
By coke-oven operators [1]	149,999	122,741	154,466	172,849	155,114	177,593	139,438	174,220	174,426	179,252
By tar distillers [2]	13,192	10,517	16,880	16,880	16,880	19,351	14,408	16,880	16,880	16,880
By petroleum refiners [3]	(4)	(4)	10,129	32,572	35,518	63,043	91,912	98,588	111,613	116,184
	163,191	133,258	181,475	222,301	207,512	259,987	245,758	289,688	302,919	312,316
Imports of pure benzene and production from imported crudes [5]	2,073	2,624	20,961	60,604	39,368	18,534	11,006	28,872	62,590	49,791
Total	165,264	135,882	202,436	282,905	246,880	278,521	256,764	318,560	365,509	362,107

[1] Bureau of Mines.
[2] 1948–49 U.S. Tariff Commission; 1950–57 estimated from data published by the Chemical and Rubber Division, Business and Defense Services Administration, U.S. Department of Commerce.
[3] U.S. Tariff Commission.
[4] Included with tar distillers.
[5] Official import statistics published by the Bureau of the Census, U.S. Department of Commerce, do not differentiate between crude and pure benzene. Pure benzene equivalent of imports is estimated at 90 percent.

TABLE 27.—*Estimated consumption of commercial benzene (excluding Motor grade), by uses, in thousand gallons* [1]

Use	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Styrene	46,000	47,500	66,000	86,000	85,000	97,500	86,000	124,000	141,000	142,000
Phenol (synthetic)	37,500	28,500	40,000	50,000	43,000	48,500	54,000	65,000	68,000	70,000
Detergents (Dodecyl benzene)	7,000	10,000	10,000	17,000	15,500	22,000	28,000	29,000	36,000	34,000
Synthetic fibers	18,000	18,000	20,000	25,000	25,000	25,000	25,000	25,000	30,000	30,000
Aniline	11,500	9,000	12,000	15,000	12,000	14,000	12,000	16,000	16,000	14,000
DDT	2,000	3,500	7,500	10,000	9,500	8,000	9,500	12,500	13,500	12,000
Di- and Mono-chlorobenzene	10,500	7,500	10,000	11,000	11,000	11,000	9,000	9,500	10,000	9,000
Maleic anhydride	2,000	1,000	3,000	5,000	5,000	4,500	6,000	7,500	7,000	7,000
Benzene hexachloride	1,500	2,000	6,000	9,500	7,000	4,500	6,000	4,500	6,500	3,500
Diphenyls	3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,500	4,500	4,500
Nitrobenzene	4,000	3,000	4,000	4,000	4,000	3,000	1,000	2,000	2,000	2,000
Miscellaneous	14,000	10,000	15,000	15,000	15,000	15,000	15,000	15,000	20,000	20,000
Export	1,700	1,300	1,300	300	200	1,200	6,400	2,500	2,700	2,700
Total	158,700	144,300	197,800	251,800	236,200	258,200	261,900	317,000	357,200	350,700

[1] American Coke and Coal Chemicals Institute.

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COKE-OVEN AMMONIA

Ammonia at coke plants is recovered in two forms: (1) an aqueous solution known as ammonia liquor and (2) a crystalline solid such as ammonium sulfate and diammonium phosphate. Tables 28–30 show production and yield of ammonia products at coke plants for the period under review. The proportion of ammonia recovered as ammonia liquor declined from 10 percent of the total ammonia production in 1948 to less than 7 percent in 1957. The reason for this decline is that most coke plants that have closed since the end of World War II made liquor, whereas coke plants, which have increased their carbonizing capacities (furnace plants), make ammonium sulfate. Diammonium phosphate, a new agricultural fertilizer utilizing coke-oven ammonia, was made for the first time on a commercial basis by a coke plant in 1955. In 1957, approximately 1 percent of the United States total coke-oven ammonia was converted into diammonium phosphate at 3 coke-oven plants.

Although chemical nitrogen was first produced in the United States by carbonizing coal, coke ovens supplied less than 7 percent of our national output in 1957 (table 31). Most ammonia used in industry and agriculture is made by synthetic processes which were first introduced in the United States in the early 1920's. The spectacular rise in synthetic ammonia output since that time has influenced prices of various nitrogen products, including coke-oven ammonium sulfate. Up to 1920, the price of nitrogen in ammonium sulfate and other nitrogen products followed the price set for nitrogen in sodium nitrate largely imported from Chile. Table 32 presents a comparison of wholesale prices on certain nitrogenous products for 1948–57. A 20-pound unit of nitrogen is taken as a basis for comparison and shows that anhydrous ammonia has had a much lower selling price than any of the other products.

TABLE 28.—*Production of coke-oven ammonia, in net tons*

Year	Total ammonia	Produced as—			
		Sulfate		Liquor (NH_3 content)	
		Quantity	Percent of production	Quantity	Percent of production
1948	238,903	830,682	89.6	24,753	10.4
1949	217,854	756,807	89.6	22,749	10.4
1950	237,622	831,016	90.2	23,386	9.8
1951	256,451	898,263	90.3	24,878	9.7
1952	228,922	802,412	90.4	22,060	9.6
1953	268,760	946,133	90.8	24,847	9.2
1954	228,225	822,818	92.9	16,103	7.1
1955	269,606	[1] 981,326	93.8	16,621	6.2
1956	251,303	[1] 906,218	93.0	17,680	7.0
1957	261,339	[1] 946,458	93.4	17,342	6.6

[1] Includes ammonium thiocyanate and diammonium phosphate.

TABLE 29.—*Average yield of coke-oven ammonium sulfate or equivalent per ton of coal carbonized, by States, in pounds*

State	1948	1949	1950	1951	1952	1953	1954	1955 [1]	1956 [1]	1957 [1]
Alabama	22.93	23.45	22.75	22.97	21.76	21.38	23.94	22.34	21.98	22.28
California	26.94	26.55	25.84	26.34	25.20	23.30	23.04	23.87	20.86	[2] 21.75
Colorado	21.32	22.46	22.35	21.66	22.97	22.40	20.48	22.78	21.48	(3)
Illinois	18.52	18.96	19.05	18.51	19.66	18.83	20.97	19.49	19.39	18.76
Indiana	16.25	16.53	16.67	16.40	16.47	17.40	17.16	15.32	14.40	15.67
Maryland	20.69	20.71	20.79	20.33	20.14	20.10	20.52	21.23	21.24	20.06
Massachusetts	14.90	17.35	18.19	17.73	18.74	18.63	20.94	20.23	19.99	17.22
Michigan	19.64	19.19	19.16	18.77	18.55	18.74	19.85	19.76	17.18	18.39
Minnesota	16.05	16.66	17.08	17.52	17.44	18.87	18.30	16.95	14.58	16.59
New Jersey	18.40	19.75	19.29	19.05	18.58	18.56	19.63	19.38	17.23	(4)
New York	18.73	20.06	19.47	19.44	20.25	22.66	24.04	22.71	22.27	22.90
Ohio	17.67	18.94	18.31	19.28	19.75	19.58	20.56	18.74	17.98	18.38
Pennsylvania	20.96	21.03	20.92	20.73	20.62	20.71	21.81	21.21	20.60	20.75
Tennessee	21.37	20.55	20.24	21.73	19.80	20.60	23.90	21.86	21.21	[5] 19.49
Texas	21.76	22.60	21.46	21.35	21.23	19.87	23.43	23.42	22.02	(6)
Utah	25.90	25.82	25.90	22.86	25.03	25.30	27.20	26.15	25.47	(6)
West Virginia	21.37	21.97	20.65	20.61	20.76	20.73	21.52	20.30	19.38	20.03
Connecticut, Kentucky, Missouri, and Wisconsin	[7] 18.47	[7] 19.08	20.40	19.31	18.29	17.35	18.81	18.27	17.58	(4)
Total	19.52	20.08	19.89	19.82	19.92	20.09	21.09	20.06	19.28	19.56
At merchant plants	18.87	20.00	20.16	20.11	20.51	20.18	21.37	19.72	18.89	19.30
At furnace plants	19.67	20.10	19.83	19.76	19.80	20.08	21.06	20.10	19.33	19.59

[1] Includes small quantity of diammonium phosphate and ammonium thiocyanate.
[2] Includes Colorado and Utah.
[3] Included with California.
[4] Withheld to avoid disclosing individual company figures.
[5] Includes Kentucky and Texas.
[6] Included with Tennessee.
[7] Includes Rhode Island.

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TABLE 30.—*Coke-oven ammonia produced by merchant and furnace plants, in net tons*

Year	Merchant plants			Furnace plants			Total NH_3 equivalent	Total nitrogen content
	Sulfate	Liquor	NH_3 equivalent	Sulfate	Liquor	NH_3 equivalent		
1948	97,575	16,310	41,465	733,107	8,443	197,438	238,903	196,498
1949	95,904	15,412	40,136	660,903	7,337	177,718	217,854	179,185
1950	100,441	14,706	40,600	730,575	8,680	197,022	237,622	195,444
1951	111,077	15,788	44,424	787,186	9,090	212,027	256,451	210,931
1952	101,042	13,889	39,938	701,370	8,171	188,984	228,922	188,288
1953	88,542	14,129	36,955	857,591	10,718	231,805	268,760	221,055
1954	63,045	10,315	26,568	759,773	5,788	201,657	228,225	187,715
1955	[1] 65,149	13,964	30,759	[2] 916,177	2,657	238,847	269,606	221,751
1956	[1] 61,267	14,450	30,245	[2] 844,951	3,230	221,058	251,303	206,697
1957	[1] 53,055	13,442	27,120	[2] 893,403	3,900	234,219	261,339	214,951

[1] Includes ammonium thiocyanate.
[2] Includes diammonium phosphate.

TABLE 31.—*Production of chemical nitrogen, by sources, in net tons*

Year	From coke ovens	From synthetic plants [1]	Total	Percent from coke ovens
1948	196,498	896,349	1,092,847	18.0
1949	179,185	1,064,362	1,243,547	14.4
1950	195,444	1,287,681	1,483,125	13.2
1951	210,931	1,461,643	1,672,574	12.6
1952	188,288	1,687,864	1,876,152	10.0
1953	221,055	1,881,703	2,102,758	10.5
1954	187,715	2,250,753	2,438,468	7.7
1955	221,751	2,674,440	2,896,191	7.7
1956	206,697	2,778,703	2,985,400	6.9
1957	214,951	[2] 3,052,228	3,267,179	6.6

[1] Bureau of the Census, U.S. Department of Commerce, Facts for Industry Series M194.
[2] Preliminary Estimate.

TABLE 32.—*Wholesale prices per unit (20 pounds) of nitrogen at producing plants or ports, in bulk carlots, by kinds of material* [1]

Year	Sodium nitrate [2]	Ammonium sulfate [3]	Anhydrous ammonia [4]	Calcium cyanamide [5]	Urea [6]
1948	$2.86	$2.03	$0.80	$2.56	$1.80
1949	3.15	2.29	.94	2.82	2.01
1950	3.00	1.95	.91	2.26	2.02
1951	3.16	1.97	.97	2.90	2.92
1952	3.34	2.09	.97	3.11	3.03
1953	3.22	2.15	1.00	2.94	3.18
1954	3.04	2.10	1.03	2.75	3.30
1955	2.98	2.12	1.03	2.75	2.60
1956	2.93	1.80	.95	2.75	2.25
1957	2.84	1.56	1.00	2.75	2.31

[1] 1948–52, from U.S. Department of Agriculture Statistical Bull. 191; 1953–57, calculated from quotations in Oil, Paint, and Drug Reporter, Hi-Lo Chemical Price Issue.
[2] Imported, crude, bulk.
[3] Coke oven, bulk, works.
[4] Fertilizer, tanks, works, freight equalized.
[5] Fertilizer, mixing grade, 21 percent N. gran., bags, contract.
[6] 45 percent N., agricultural, bags, delivered.

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